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ROYAL AIRCRAFT ESTABLISHMENT

FARNBOROUGH, HANTS

TECHNICAL NOTE: No. ARM.534

DEVELOPMENT OF THE INDICATOR, ANTI-SUBMARINE, TRAINING No.1, Mk.1

by

L. RATCLIFF, A.M.I.Mech.E.

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Technical Note No. Arm.534

January, 1954

ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

Development of the Indicator Anti-Submarine Training No.1 Mk.1

by

L. Ratcliff, A.M.I.Mech.E.

R.A.E. Ref: Arm.3640

SUMMARY

The Anti-Submarine Training Indicator has been developed for simulating and evaluating attacks from the air against submerged submarines. It consists of an explosive sound unit attached to a float, containing the candle unit also used in the Float, Smoke and Flame 3½ lb No.1 Mk.1.

The trials described show that the sound unit is very reliable, but that the functioning of the smoke unit is impaired in seas rougher than State 2 because of water ingress.

A sound unit containing 2 oz of Thunderflash composition can be heard by a submerged submarine at a range of 3000 yards whilst in moderate conditions of sea and wind, the smoke (by day) and the flame (by night) can be distinguished from the air at a range of 3 miles.

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1 Introduction

The work was carried out in aid of Joint Naval/Air Staff (O.R.1070) requirement (extract attached) and continues that already reported[1] with prototype Indicators.

2 Scope of Report

The report;

(I) Describes the Indicator (prototypes and current store) and method of functioning.

(II) Summarizes the limitations found in the prototype (from the development and Service trials covered by the reports[1,2,3]) and the improvements embodied in the current store.

(III) Describes the conduct and outcome of the further development and Service trials since the prototype stage.

(IV) Furnishes the overall results and conclusions.

3 Description of Indicator and Method of Functioning

(I) Description (Fig.1) and events to smoke emission

Note In layout generally and method of functioning the current Indicator remains identical with the prototype. A sound charge of SR.801/B (Thunderflash) composition is housed in a container affixed to the forward end of a modified Float Smoke and Flame 3½ lb No.1 Mk.1. The modifications entail primarily, the provision of a liner to support the float body and a special emission orifice, necessitated by the severe crushing loads transmitted from the underwater functioning of the sound charge.

The sound unit operates at about 20 ft (depending on the height and speed of the aircraft) following the release of the Indicator from the carrier, arming by orthodox Vane cap, impact striker actuation and burning of a 2 second pyrotechnic delay. The smoke and flame unit is given buoyancy and initiated by utilizing the explosive pressure of the SR.801/B to separate the Signal Container from the float about a "weak link joint" and to depress a secondary diaphragm carrying a striker. A candle unit filled SR.414 (Red Phosphorus Mixture 10½ oz), ignites following the burning of a 10-12 second Bickford fuze delay, and a diaphragm which ruptures under internal pressure, after the float has surfaced, allows smoke and flame to be emitted for a time of 5 minutes (approx.).

Outline, weight, C. of G. characteristics are as follows:

Diameter 3.1" (5.5" over fins),
Length 27.6",
O/L Weight 10 lb,
C. of G. from extreme nose - ratio 0.28.

(II) Action of main filling

On initiation some of the constituents of the SR.414 mixture react, generating heat which causes the phosphorus present to be emitted as an easily condensible vapour; on coming into contact with the air this burns to give flame, and white smoke.

4 Limitations of Prototype - Improvements in Current Store

A summarised comparison enumerating the modifications made is given at Appendix II.

5 Conduct and Outcome of Development and Service Trials (Summary Appendix III)

Note As the instances of inaudible functioning of the 2 oz sound charge reported by A.S.W.D.U.3 were due possibly to inadequate charge weight as distinct from faulty confinement, and the inference[3] that a heavier charge might be required for detection of the signal by a submarine at maximum depth and range, a 4 oz charge was employed in the majority of the trials described hereunder. The use of a 2 oz charge (as later demanded by the Admiralty) is specifically stated.

5.1 Signal Container

(I) Separation Joint

The method of jointing was modified as follows:-

(i) Use of rivets as the main retaining agent for improved strength and consistency in shear.

(ii) Use of fillet of solder for sealing only.

Thus arranged the joint was designed to separate under an axial load of 1-1.25 tons.

This was expected to give the desired conditions of confinement for the SR.801/B, loading without rupture of the secondary diaphragm, and for rupture of the Signal Container at its weak rear end and not along the longitudinal seam.

Full scale proof tests were preceded by mechanical tests in which the joint was found to shear consistently between 0.9 and 1.2 tons.

(II) Safety Provision

Tests were undertaken to verify the effectiveness of the provision made to prevent a live store functioning if accidently dropped 20 ft nose down on to concrete. It was found that the stiffener plate affixed to the nose cap, prevented functioning.

The sealing of the rubber ring for preventing ingress of moisture (necessary for the safe storage of the SR.801/B composition) was tested and found effective under internal air pressure of 10 lb/in^2.

5.2 Float Unit

In equipping the float to withstand the high crushing forces imparted by the functioning of the sound unit Fig.2 it was considered that the spruce liner support should be replaced by materials possessing:

(I) Higher radial compressive strength.

(II) Low and consistent density (for floatation).

(III) Low Moisture content (to improve the shelf life of the pyrotechnic compositions).

The use of a resin bonded paper liner, with aluminium alloy end and 0.014" M.S. outer casing Fig.1/2 promised to fulfil all requirements. To obtain a freeboard of 3" it was necessary to increase slightly the length and weight of the float.

5.3 Candle Unit

Much time was spent in eradicating the design and manufacturing faults (Appendix II) exposed in this unit by the prototype trials and further deficiencies encountered later sufficed in no small measure to hamper the development.

5.4 Development and Service Trials (Summary Appendix III)

(I) Indicators used

The trials were undertaken with Indicators manufactured and filled by the same contractors:-

(a) Lot 1. Qty. 250 incorporating modifications 1-4, 8-11 and 13 ordered 12/50 - available 4/51, modifications 6, 7, 8A and 14 being embodied subsequently.

(b) Lot 2. Qty. 100 ordered 1/52 embodying all improvements of 1st Lot plus modification 5 and 12. Trials commenced 1/53, modifications 8B and 15 were embodied as a result.

(c) Lot 3. Qty. 1000 Service order for trials (Exercise Mariner 1953) modified by reversion to 2 oz sound charge as requested by Admiralty.

5.4 (II) Development Trial 1. Stores Lot 1

(Note Where reference is made to the float only it may be taken for all trials, that sound unit functioning occurred).

Qty. 6 Indicators were dropped. The results tended to confirm that consistency of signal container separation and adequacy of body strength had been attained. Smoke emission was either not given or was of poor quality.

Outward bulging and or splitting of the casing rear end, non bursting of the rupture disc (0.0015 thick copper foil) or complete removal of the emission housing confirmed the presence of excessive pressure within the floats at ignition.

5.4 (III) Development Trial 2. Stores Lot 1

Qty. 6 stores were statically functioned, arranged:-

All with copper rupture discs 0.0015" thick and emission orifice enlarged 0.313" to 0.380" diameter:-

(i) 3 with blow out disc remaining at 0.75" diameter.

(ii) 3 with blow out disc enlarged to 0.93" diameter (Mod.6).

All ignitions were satisfactory and at a lower pressure than hitherto, there being no emission housing failures and almost complete absence of end bulging in the floats as described in 5.4 (II).

Each float was only dunked once - by the reaction from the functioning of the rupture disc. Despite these favourable conditions all emissions were poor and of short duration.

From the finding of considerable quantities of condensed phosphorus within the floats it was considered that the poor performance had resulted mainly from an excessive cooling of the phosphorus vapour caused by the reduction in thickness of the liner and increase in cooling area of the lengthened float chamber.

5.4 (IV) Development Trial 3. Stores Lot 1

Following static tests, air drops were undertaken on to a choppy sea with stores having orifice 0.380" diameter, blow out disc 0.93" diameter rupture disc (copper) reduced to 0.0005" thickness (Mod.7) - this being to reduce rupture disc reaction and initial dunking - and with alternative means for reducing the cooling of the phosphorus vapour.

(i) Qty. 3 - inside of support liner lagged with 6 turns of 0.008" thick asbestos paper, Fig.1/3.

(ii) Qty. 3 - 1" diameter × 17 S.W.G. Duralumin central chimney fixed to and extending from the candle unit to the emission orifice. Fig.1/4.

All floats emitted smoke including one with central chimney dropped short on land. Smoke from the remaining pair of this type was poor and lasted only 2 minutes as a result of the chimney being melted by the heat from the priming pellet.

Two of the asbestos lagged floats gave fairly good smoke for 5 minutes, plus, though condensed, phosphorus was found in some quantity on the liner walls, from which the asbestos had shrunk by the action of the heat.

The smoke given by the third asbestos lagged float which was dunked repeatedly, was poor to nil at 3 minutes. The emission after a low pressure start was undoubtedly impaired by water entering through the emission hole.

5.4 (V) Development Trial 4. Stores Lot 1

The preceding trials indicated that the conditions to be satisfied for the prevention of cooling of the vapour and of the ingress of water, accepting that no great increase in freeboard could be given to the float were:

(i) Prevention of access of the phosphorus vapour to the cool walls of the float chamber.

(ii) The size of orifice to be adjusted so as to maintain a pressure of vapour inside during functioning; thus to reduce the tendency for water to enter.

The provision of an emission cone which could readily be accommodated within the float by cutting the support liner into two parts (Mod.14) Fig.1/5 offered to fulfil the requirements.

It was thought that the large diameter at the lower end of the cone would render it immune from destruction by the priming pellet and that the conical shape gave advantages of low weight and good heat insulation.

Following promising static trials Qty.6 Indicators were dropped with emission cones in 24 S.W.G. mild steel, internally lagged with 2 turns of 0.008" thick asbestos paper and with orifices reduced to 0.313" diameter (Mod.8). Much improved smoke emission was given by all stores up to the time of their recovery (2-3 minutes).

The sudden extinction of the emission at about 2 minutes of three of the floats was attributed to water entry through the emission orifice, and at the forward joint due to faulty sealing. Little condensed phosphorus was found in the floats.

5.4 (VI) Development Trial 5. Stores Lot 1

To save weight whereby freeboard was improved from $1\frac{7}{8}$" to 3" and to further prevent water entry through the emission hole Qty.6 stores were dropped having cones in 20 and 24 S.W.G. Aluminium lagged with 3 turns of asbestos paper and emission orifices reduced to 7/32 diameter (Mod.8A).

The functioning of these stores was satisfactory throughout. In light sea and wind conditions all gave good smoke and flame, Fig.3 for times ranging from $5\frac{1}{2}$ to 7 minutes. These results having shown that the ideals of store arrangement and performance had almost been attained, clearance was accordingly given for the completion of manufacture of the outstanding Indicators (with 20 S.W.G. Aluminium emission cone as preferred by manufacturers).

5.4 (VII) Development Trial 6. Stores Lot 1

Trials with Indicators arranged as for Trial 5 were undertaken at the request of A.S.W.D.U. Calshot to verify functioning when released at 150 ft and 120 knots as required for Sunderland aircraft.

Satisfactory initiation and sound unit functioning was given by all (12) stores. Nine of the floats gave smoke, three did not, including two which failed to surface. Five of the floats recovered were found to be without the orifice housing and this was traced to faulty soldering. It was thought probable that its displacement on impact, allowing water entry, was responsible for the poor performance of some of the other floats.

5.4 (VIII) Service Trials A.S.W.D.U.[5] Stores Lot 1

The smoke output of 20 Indicators, tested in seas up to State 3, was considered unsatisfactory.

The sound from 19 of them was heard at distances between 60 and 2,400 yards.

From the times of burning reported, R.A.E. suspected that the emissions had been impaired by water entry, probably caused by poor soldering of the orifice housing.

5.4 (IX) Service Trial A. & A.E.E. 1st Acceptance Assessment Stores Lot 1

(a) Day assessment[6]

No failures in sound unit functioning were experienced in drops (20) made from Firefly and Sea Prince aircraft from heights 50-1,000 ft and speeds 150-300 knots.

The smoke emissions given from the stores in calm sea and wind conditions were reported to be sparse, erratic and generally of short duration. Considering the favourable sea state this behaviour was only reconcilable with water having entered the floats due to inadequate soldering of the orifice housing and its resultant displacement at impact, and or to ineffective sealing of the forward closure.

(b) Night assessment[7]

Four Indicators dropped from 1,000 ft performed:-

No.1 - Sound unit functioned - flame emission given for 7 minutes.
No.2 - " " " " " " " "
No.3 - " " " " " " ½ minute only.
No.4 - " " " " not given.

The flame emissions from Nos.1 and 2 were reported as being clearly visible from 3 miles in a rainstorm and were likened in brilliance to a sodium type street lamp.

5.4 (X) Development Trial 7[9] Stores Lot 2

By modifications (5) and (12) the sealing of the float units of these stores was expected to be improved, especially at the forward closure, where effective sealing on some previous occasions, had been prevented by thread stripping or complete breakaway of the brass hank bushes in the candle unit. Steel bushes more firmly anchored were substituted.

Proof results of Qty.12 stores dropped were:-

Eleven stores functioned correctly to smoke emission; the remaining store failed to initiate at the sound unit. Five floats placed very close inshore over rocks in extremely rough water (estimated state 5) suffered repeated dunking (2-3 second intervals). In consequence, all emissions were sparse and of short duration (3 minutes maximum).

Six stores dropped more favourable out at sea (state 2); all gave reasonable smoke emission for times ranging from 4-6 minutes and were located by the aircrew from about 3 miles.

Four floats recovered after dropping into the rough water were found to be satisfactorily sealed. This indicated that water had entered these floats, during the dunking, through the emission orifice. A further reduction in the orifice size and resultant boosting of the emission pressure was therefore decided upon for the attainment of an effective emission in rough seas.

5.4 (XI) Development Trial 8[10] Stores Qty 6 each Lots 1 and 2

With emission orifices reduced to 5/32" diameter (Mod.8B) to improve smoke performance in rough seas stores were dropped for comparison alongside Markers Marine 19 lb 20 miles outsea in the English Channel in conditions, sea, state 3-4, wind 30 knots, visibility 1-3 miles. The distraction of many white caps on the sea and difficulty of orbiting the aircraft within the short visibility made it extremely hard to locate the markers (both types) and keep them in sight. Consequently, or because of malfunctioning, the emissions from four of the Indicators were not located.

Except for two instances, when smoke was continuing to be emitted at 3 minutes plus, it was not possible to measure the time of burning of

the eight Indicators which were seen to produce smoke. Air photographs of four of these are given in Fig.4. A photograph taken of a Marker Marine emission with that from an Indicator alongside Fig.4/4 failed to register the former. Visually, the emission from the Indicator was adjudged to be as effective as that produced by the marker.

5.4 (XII) Development Trial 9[10] Stores Lot 2

A dropping trial, as reproof of Trial 8, was undertaken with Qty.6, Indicators additionally modified (15) to have the sealing ring plate in aluminium instead of steel thereby saving weight and improving freeboard from 3"-4" approximately.

Owing to an urgent demand for design clearance and a period of bad weather the stores were eventually dropped in poor conditions, - visibility 3-4 miles, wind 0.07 knots, sea calm.

All sound units functioned correctly and the floats gave smoke (Fig.5), identified by the aircrew from 3-3½ miles, for periods up to 6 minutes.

5.4 (XIII) Service Trial A. & A.E.E.[11] 2nd Acceptance Assessment Stores Lot 2

Of Qty.40 Indicators supplied arranged as for Development Trial 9, Qty.8 were dropped and compared for smoke performance with Candles (Naval) Smoke White Mk.4 (used from submarines for position marking) and Markers Marine No.2 Mk.2.

In conditions of bright sunlight with haze, 10 knot wind and calm sea state, the smoke trails from the Indicators were adjudged to be superior to those produced by the Naval Stores but inferior to those given by the Markers Marine.

Other than up sun however when the emissions from all of the stores were difficult to locate from beyond 1½ miles, the smoke trails from the Indicators were visible from 3-5 miles.

As a result of these trials it was decided that a quantity of 1000 Indicators in urgent demand for Service exercises should be made to this design.

5.4 (XIV) Development Trial 10[12] Stores Lot 2

A design modification for the provision of a reduced sound charge in the 1000 Indicators ordered for Service use was necessitated by Admiralty deciding not to accept the risk of the 4 oz charge exploding close alongside a submarine's pressure hull.

Consequently, Indicators with Sound Charge reduced to 2 oz by the fitting of a rolled paper liner within the sound container (Fig.1/6) under went proof trials.

(i) Statically, Qty.1 - with satisfactory results.

(ii) From the air, Qty.4, together with Qty.4 Candles (Naval) Smoke White Mk.4 launched from a marine craft as aiming marks and for further comparison of smoke performance.

In conditions, visibility 2-3 miles, wind 15-20 knots and choppy sea it was found that:

(i) All the Indicators functioned correctly.

(ii) The emissions of the Indicators, given for times ranging from 5½-6½ minutes were clearly visible from the air up to the range of visibility (3 miles maximum).

(iii) Except for the first minute of burning when a fair cloud of smoke was given, all emissions from the Candles Smoke White were so difficult to locate from the air that three runs over the area were necessary before the first pair of indicators could be dropped.

As a result of this satisfactory proof the design was amended to show the 2 oz charge and the 1000 Indicators for Service trials made accordingly.

5.4 (XV) Service Trial A.S.W.D.U.[13] Stores Lot 3

Trials were undertaken with 44 Indicators off Cape Wrath in conjunction with H.M. S/M Auriga, to assess the audibility range of the store with modified (2 oz) sound unit and to determine its suitability for Service use.

In weather, fair, visibility 15-20 miles, surface wind 5-10 knots and slight sea state, the results given were:

(a) Serviceability

Sound Unit - 95.5% - (2 explosions not heard)
Smoke Unit - 88% - (5 gave smoke for less than 1 minute)
Overall Unit - 84% - (7 unserviceable sound or smoke).

(b) Sound Unit - Audibility Range
(c) Smoke Unit - Burning times
} See graphs reproduced at Appendix IV.

(d) Smoke Visibility Ranges - observations were not reported.

It was reported that three stores came loose on their carriers allowing the arming vanes to rotate and fall off and it was suggested this might be prevented by the use of:

(a) Crutch Adaptors

(b) An Arming Wire

Subject to modification in these respects it was considered the store was suitable for Service use.

5.4 (XVI) Ballistic Assessment Trials

It has been found from the results of drops[14] with 12 stores that the ballistic properties for the Indicator are as follows:

(a) Stability - good

(b) Terminal velocity 370 f.p.s.

(c) Standard Deviation 12.

5.4 (XVII) Storage and Transit Provision

(i) Handling and Rough Usage

Rough usage and Jolting Tests[15] have shown that the Box B.628 Fig.6 designed to carry 4 Indicators, gives the requisite protection for the store. This pack was provided for the Lot 3 stores and is now fully approved for Service use.

(ii) Climatic Tests

Tests, held up pending the availability of stores, are being arranged.

6 Discussion of Results

(i) Initiation of Sound Unit

Air drops of 166 Indicators from heights ranging from 50-1000 ft and at speeds between 120-300 knots are reported here.

The sound units of 7 of these stores (possibly less) failed to function (4.2%).

It is not possible to assess the proportion of those that failed due to:

(a) Flat strikes.

(b) Non detachment of the arming vane.

(c) Pyrotechnic fault.

(ii) Audibility of Sound Unit

Investigations into this are incomplete and the available data is limited. Nevertheless, it appears from A.S.W.D.U's experience and observations in their trials of the modified store that, in fair conditions, the 2 oz sound charge can be heard by submarines at periscope depth over ranges up to 3000 yards and possibly up to 5000 yards. Insufficient data is available for determination of ranges for the 4 oz charge and for the 2 oz charge in severe seas and with the submarine at varying depths etc.

(iii) Signal Container Separation and Initiation of Float

Except for the failures in Lot 1, due to faulty design and manufacture, the performance has been consistently good with no serious damage to the float.

(iv) Smoke and Flame performance

The results of the early development trials 1-3 showed that the production of smoke and flame from SR.414 composition is reduced to negligable proportions if water gains access to the composition, or if the phosphorus vapour is inadequately protected against cooling. Performances approaching the stated requirement and possibly the best which may be expected from the amount of filling employed have been obtained latterly. This has resulted from the insulation provided by the fitting of the omission cone and by the reduction of the emission orifice to prevent ingress of water. Experience has shown (Trials 4, 6, 7, 8 Appendix III) that the effectiveness of these features is nullified if during functioning, water is allowed to enter the float through imperfect or damaged joints.

It has been found that providing the float is made and sealed to the designs and specifications it will not leak after exposure to the severe pressure given by the functioning of the sound unit. The need for this care particularly at the forward main closure was constantly emphasized.

It was shown to be equally important that the blow out disc was a free fit in the emission housing otherwise joints were blown due to excessive internal pressure.

Serviceability of the float since the advent of reasonably effective jointing, Trials 9, 11, 13 and 14, Appendix III(excluding functioning in seas state 3 and greater) was:

(a) Gave smoke 96.5%

(b) Gave smoke effective for use - 3 to 5 minutes plus - 75% approx.

See also Appendix IV.

7 Conclusions

The development trials of the A.S.T.1 show that, when properly made, it can be expected to:

(i) be satisfactory for carriage (provided crutch adaptors and the Mk.1A attachment are used) and release from carriers L.S. (internal and external stowages) from heights of 50-1000 ft and speeds 120-300 knots.

(ii) possess acceptable, aiming, arming, and initiation characteristics.

(iii) function its sound unit at a depth of approximately 20 ft.

(iv) with a 2 oz charge, be heard at ranges up to 3000 yards (5000 yards in favourable conditions) by a submarine at periscope depth and a little below.

(v) with a 4 oz charge be heard at ranges up to 5000 yards under similar conditions.

(vi) give a smoke trail identifyable photographically from white caps, and visible by day, from the air, from 3-5 miles, under conditions of moderate visibility with winds up to 25 knots and in sea states up to 2 (or possibly 3).

(vii) give a flame visible by night from at least 3 miles under similar conditions.

(viii) maintain its emission of smoke and flame for a minimum of 3 minutes on 75% of occasions under these conditions.

(ix) give a performance markedly superior to that of the Candle (Naval) Smoke White Mk.4 in these conditions.

(x) give less smoke for a shorter time, due to ingress of water if used in sea states rougher than 3, or in winds stronger than 25 knots. (The visibility of the smoke will be further reduced owing to attenuation).

(xi) be satisfactory for handling, transportation, and storage.

8 Future Developments - Recommendations

(i) Crutch adaptors and the Mk.1A fuzing attachment should (as intended) always be fitted and used when the A.S.T.1 is carried on L.S. carriers. These fitments correctly applied make unnecessary the provision of an arming wire to the vane cap as suggested by A.S.W.D.U. which could cause instability and malfunctioning of the store in low level releases.

(ii) Service usage of the store should seek to ascertain:

(a) The optimum weight of sound charge desirable for detection by submarines at maximum depth and range in waters of steep salinity and temperature gradients and for their safety at periscope depth against an Indicator functioned close alongside.

(b) Whether it is necessary to use the Indicator in seas above state 3 and winds above 25 knots. If so, whether its impaired performance under these conditions is acceptable.

(iii) Investigations are continuing to improve (by further reducing heat losses) the burning efficiency of Red Phosphorus mixtures in sea markers.

(iv) The method of closing and sealing the forward joint of the float unit should not be perpetuated in any future mark of Indicator (or Sea Marker) for the reasons:

(a) Unsuitability as quantity production method (48 hours for cement to set).

(b) Doubtful effectiveness of cementing for storage safety and underwater sealing after long shelf life.

Given sound sealing (welding-soldering) at this and at other joints the incidence of leaks and cooling would diminish greatly to give a more efficient utilization of the excellent smoke and flame giving properties of the SR.414 filling.

(v) The deficiencies revealed in the components common to the Float Smoke and Flame 3½ lb No.1 Mk.1 during this development has been rectified in the latter store designs.

Acknowledgements

The assistance and data provided by R.A.F. units and Messrs. Schermuly Pistol Rocket Apparatus Co. in support of this work is acknowledged with thanks.

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6	-	A/S Training Indicator - Acceptance Trials A.A.E.E./5908., A.O.C., A. & A.E.E. to M.O.S. R.D.Arm.2 5/52
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9	-	Indicator A/S Training No.1 Mk.1 - Proof Trials R.A.E. Arm.3640/LR to M.O.S. R.D.Arm.2 12/52
10	-	Indicator A/S Training No.1 Mk.1 - Rough Sea Trials R.A.E. Arm.3640/LR to M.O.S. R.D.Arm.2 2/53
11	-	Anti-Submarine Training Indicator - Smoke Comparison A.A.E.E.5913/3 A.O.C., A. & A.E.E. to M.O.S. R.D.Arm.2 4/53
12	-	Report on Trial of Indicators A/S Training No.1 Mk.1 and Candle (Naval) Smoke White Mk.4 A.T.D.U.(D)/52/10/Air C.O., A.T.D.U. Detach., Weston-S-Mare to D.R.A.E. 7/53
13	-	Report on Trial No.337 - Audibility of the modified Anti Submarine Training Indicator A.S.W.D.U./C20/464. Trials A.S.W.D.U. R.A.F. St. Mawgan to H.Q. C.C.
14	-	Trial No.294 Indicator A/S Training No.1 Mk.1 Ordfordness Research Station 113/2/A/7 to D.R.A.E. 11/53
15	-	Indicator A/S Training No.1 Mk.1 - Rough Usage Trial of Package I.A./22/323/1 D.I.Arm to D.R.A.E. 4/53.

Attached:

Appendices I to IV Drg: Sk.Arm.46483 (Appendix IV)
Negative Nos. 110,249 to 110,254
Detachable Abstract Cards

Advance Distribution:

D Arm RD (Air)
AD Arm RD2
NAD Arm RD
RD Arm 2
TPA3/TIB 60
Sec Ordnance Board (for Pyrotechnics Panel)
Director, RAE
DDRAE(E)
Head of Armament Dept
Armament Dept 20
Library

APPENDIX I

Naval Air Staff Serial No. AWD.61
Air Staff No. OR.1070
Combined Staff No.
Admiralty Docket No. AWD.631/47

Extract from Joint Naval/Air Staff Requirement for an Anti Submarine Training Indicator No.1070

OBJECT

1 The Staffs require a droppable store which will give a visual indication of its position on striking the water and which will also on impact fire a small explosive charge audible to a submarine.

METHOD OF USE

2 It is intended that the submarine, on hearing the explosion of the charge when the store strikes the water, should release a smoke candle; the aircraft will then record, photographically if possible, the bearing and distance between the smoke candle and the point of impact of the store.

MILITARY CHARACTERISTICS

3 Release Conditions

The store must function satisfactorily when released at heights between 50 and 1,000 ft at speeds between 150 and 300 knots (400 knots if size and weight factors permit).

4 Identification

(a) The store must emit smoke for at least five minutes after striking the water; the smoke by day or flame by night must be clearly visible from heights up to 1,000 ft from a range of three miles in moderate weather conditions, including winds up to 30 knots.

(b) The colour of the smoke emitted must not be red or yellow so as to avoid confusion with emergency signals from submarines.

(c) The explosive charge must be clearly audible to submarines at ranges of at least 2000 yards.

5 Safety

(a) The store must be fitted with devices to prevent its accidental functioning during handling and loading operations. There should be a means of jettisoning the stores safe.

(b) The charge should not be sufficient to cause damage to the hull of a submarine when exploded in contact with it. It should not plunge to a depth of more than 30 ft under any conditions of release, nor be capable of causing serious damage to the submarine in the event of an accidental "dry hit".

6 Carriage

The store is required to be carried and released from a light series carrier. In M.R. aircraft, it should be possible to reload carriers while airborne.

7 Transport Handling Storage

The store must be acceptable to the Explosive Storage and Transport Committee for handling and sea trahsport, and be suitable for stowage in H.M. ships.

APPENDIX II

Indicator A/S Training No.1 Mk.1

Summary - Prototype Limitations - Improvements in current design

Prototype		Final Provision	Mod. No.
Component and or defect	Effect on functioning	Merit	
Signal Container			
Separation joint - uncertain soldering	Weak sound signal - non-initiation of float	Rivets for consistency in strength and shear	1
Maltreated arming threads	Arming failures	Process perfected	2
Float Unit			
Body collapse	Loss buoyancy and smoke and flame	Improved support liner	3
Unsound fore jointing*	Leaks, cooling	Improved	4
Unsound aft jointing*	Leaks, cooling	Improved	5
Too small blow out disc	Excess internal pressure - leaks	Enlarged to optimum	6
Overthick rupture disc	Excess internal pressure - leaks	Reduced to optimum	7
Overlarge emission orifice	Water entry - damping of emission		8
	" " " " "		8A
	" " " " "		8B

*Indicates defect found in design of Float Smoke and Flame $3\frac{1}{2}$ lb No.1 Mk.1

Prototype		Final Provision	Mod. No.
Component and or defect	Effect on functioning	Merit	
Candle Unit			
Faulty Delay Holders*	Breakdown ignition	Redesigned, perfected	9
Uncertain pellet retention*	Breakdown ignition	Retainer provided	10
Defective fabrication*ø	Erratic burning	Improved processing	11
Defective anchorages*	Bad jointing - leaks	Redesigned	12
Faulty striker arrangement*ø	Non initiation	Design and manufacturing improvements	13
Inadequate insulation of emission	Cooling, ineffective emission	Cooling reducer (Emission Cone) fitted	14
Inadequate freeboard	Cooling, ineffective emission	Improved	15

*Indicates defect found in design of Float Smoke and Flame 3½ lb No.1 Mk.1
øIndicates defect accentuated by faulty manufacture

APPENDIX III

Indicator A/S Training No.1 Mk.1

Summary of Proof Functioning Trials - Conditions and results (Trials all by day except 8b)

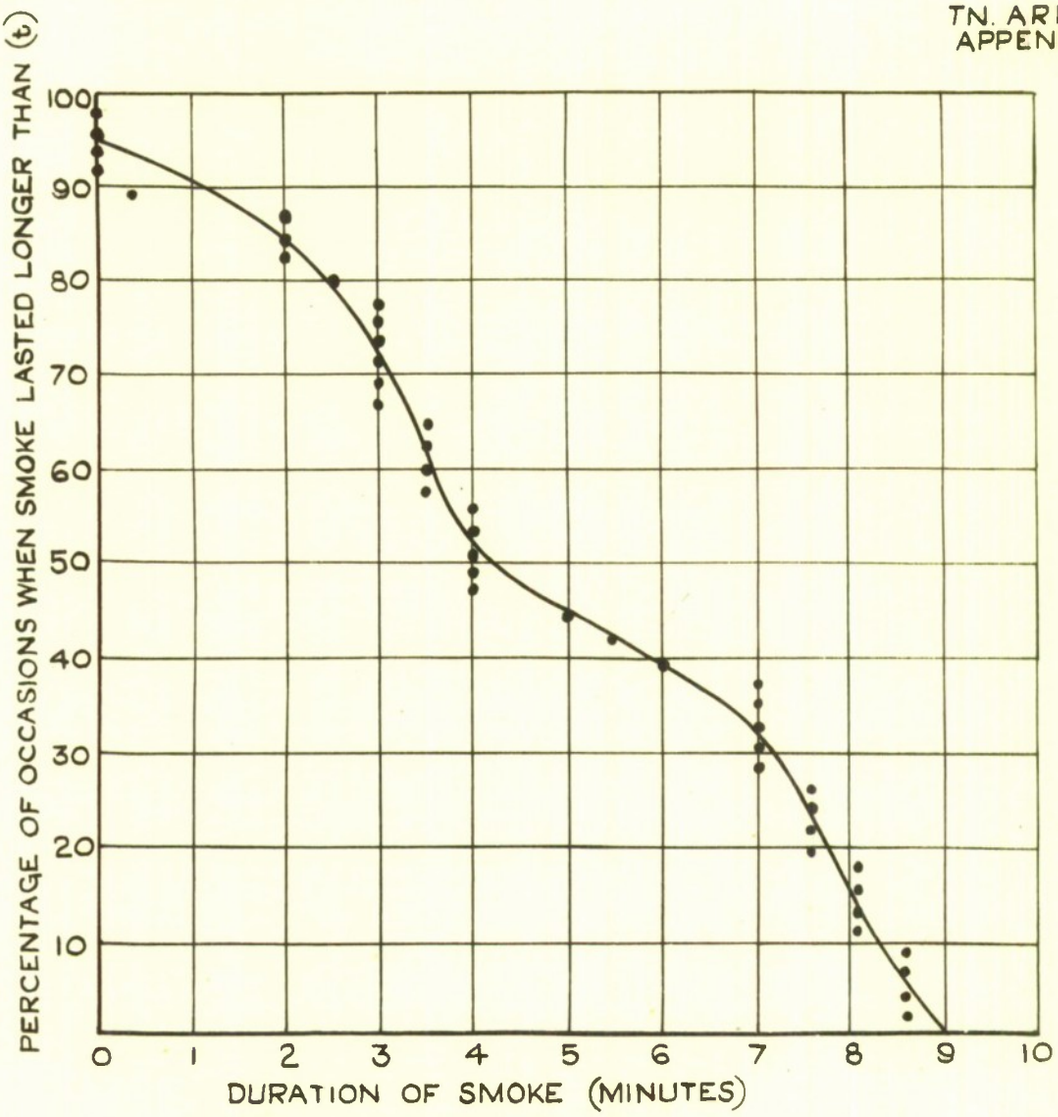
Trial No.	Agent	Stores Qty. and Manuf. Lot	Venue Date	Object	Arrgt Fig. No.	Aircraft Release Conditions	Met. and sea Conditions	Sound Unit			Given	Smoke and Flame			Visibility from air	Remarks
								Functioned	Failed	Range yds to S/M		Not Given	Quality	Time Minutes		
1	RAE DTI	6/1	Weston-S-Mare 7.4.51	Initial overall proof	1/2	Lincoln 150 ft 150 knots	No record	6	Nil	No S/M	3	3	Sparse	1½ rec	Not taken	Excess internal pressure in float unit
2	RAE DT2	6/1	S.P.R.A. Co.	Improve smoke and flame	1/2	Static pond	-	5	1 firing adaptor failure	-			Sparse	1-2	-	Internal pressure reduced - over cooling of emission
3	RAE DT3	6/1	Weston-S-Mare 9.5.51	Ditto by insulating emission	1/3 1/4	Lincoln 150 ft 150 knots	Sea choppy	6	Nil	No S/M	6	Nil	Fair Sparse Good	2(3) 3(1) 5(2)	Not taken	Further improve insulation-boost pressure emission
4	RAE DT4	6/1	Weston-S-Mare 5.6.51	Ditto and reduc. of orifice	1/5	Lincoln 150 ft 150 knots	Wind fresh Sea choppy	6	Nil	No S/M	6	Nil	Good to 2 min.	2-3 mins rec.	Not taken	Performance curtailed by faulty sealing
5	RAE DT5	6/1	Weston-S-Mare 21.6.51	Ditto and with improved buoyancy	1/5	Lincoln 150 ft 150 knots	Wind fresh Sea choppy	6	Nil	No S/M	6	Nil	All good (Fig.3)	5½-7	Not taken	Satisfactory performance arrange future stores likewise
6	RAE DT6	12/1	Weston-S-Mare 30.10.51	Initiation at 120 kts release	1/5	Lincoln 150 ft 120 knots	Sea calm	12	Nil	No S/M	9	3	F. Good F. Good	4+ (5) 2½ (4)	Not taken	Performance impaired faulty workmanship
7	ASWD	20/1	North Channel 7.51	User trials	1/5	Sunderland 500 ft 120 knots	Winds 9-34 knots Sea state 1-3	19	not 1 heard	60-2,400	14	6 not seen	Accept Paint Not) seen)	5+(4) 1-4(10) (6)	Inadeqt.	Performance impaired faulty workmanship
8(a)	A. & AEE	20/1		Service assess. and approo.	1/5	Firefly Sea Prince 50-1000 ft 150-300 kts	Vis. hazy Wind 10 kts Sea calm	20	Nil	No S/M	16	4	4 only satisfy	1 to 9½	3 miles -¾ miles	Performance impaired faulty workmanship
8(b)	A. & AEE	4/1		Service assess. Night trial	1/5	Sea Prince 150 knots 1000 ft		4			3		Good	7(2) ½ 1		Clearly seen brilliance sodium street lamp, from 3M in rainstorm

Trial No.	Agent	Stores Qty. and Manuf. Lot	Venue Date	Object	Arrgt Fig. No.	Aircraft Release Conditions	Met. and sea Conditions	Sound Unit: Functioned	Sound Unit: Failed	Sound Unit: Range yds to S/M	Given	Smoke and Flame: Not Given	Smoke and Flame: Quality	Smoke and Flame: Time Minutes	Visibility from air	Remarks
9	RAE DT7	12/2	Weston-S-Mare 3.12.53	Proof new Manuf. lot	1/5	Lincoln 50&1000 ft 150&220kts	Vis. 3-4 miles Wind 24kts Sea state 2	11	1	No S/M	11	1	F. Good Sparse	4-6(6) 1-3(5)	3 miles	Dropped turbulent water over rocks - excessive dunking
10	RAE DT8	6/1 6/2	English Channel	Improve smoke and flame in rough seas - reduced orifice	1/5	Lincoln 1000 ft 150 knots	Vis. 1-3 miles Wind 30kts Sea 3-4	8 4 No check		No S/M	8	4 not located	See photos Fig.4	Timing not pos.	See photos Fig.4	Emissions difficult to locate and hold in prevailing visibility and sea background
11	RAE DT9	6/2	Weston-S-Mare 17.1.53	Ditto and with improved buoyancy	1/5	Lincoln 100 ft 150 knots	Vis. 3-4 Wind 10kts Sea calm	6	Nil	No S/M	6	Nil	Good V. Good Good	2-3(1) 6(4) 4(1)	3-3½ miles	See photos Fig.5
12	A. & AEE	8/2 (40 supplied)	Lyme Bay	Service Appl. Comparison Naval Candle White Mk.4 and Marker Marine No.2 Mk.2	1/5	Shackleton 1500 ft 150 knots	Vis. hazy Wind 10kts Sea calm	8	None reported		8			Not given	3-5 miles except up sun	Smoke superior to Candle White Mk.4 inferior Marker Marine
13	RAE DT10	4/2	Weston-S-Mare	Proof 2 oz Sound charge and comparison Smoke Naval Candle White Mk.4	1/6		Vis. 2-3 miles Wind 15-20K Choppy	4	Nil		4	Nil	Good	5½-6½(4)	3 miles	Indicator emissions clearly identified. Candles Naval Mk.4 not
14	ASWDU	44/3		Proof Audibility Range modified (2 oz sound) stores	1/6	400 ft 160 knots	Vis. 15-20 miles Wind 5-10 knots Sea slight	42	2 not heard		37	2 5 less than 1 min.	No details given	3+70% 4+50%	Given only in terms time of burning	Serviceability O/L 84% Sound Unit 95.5% Serviceability Smoke unit 88%

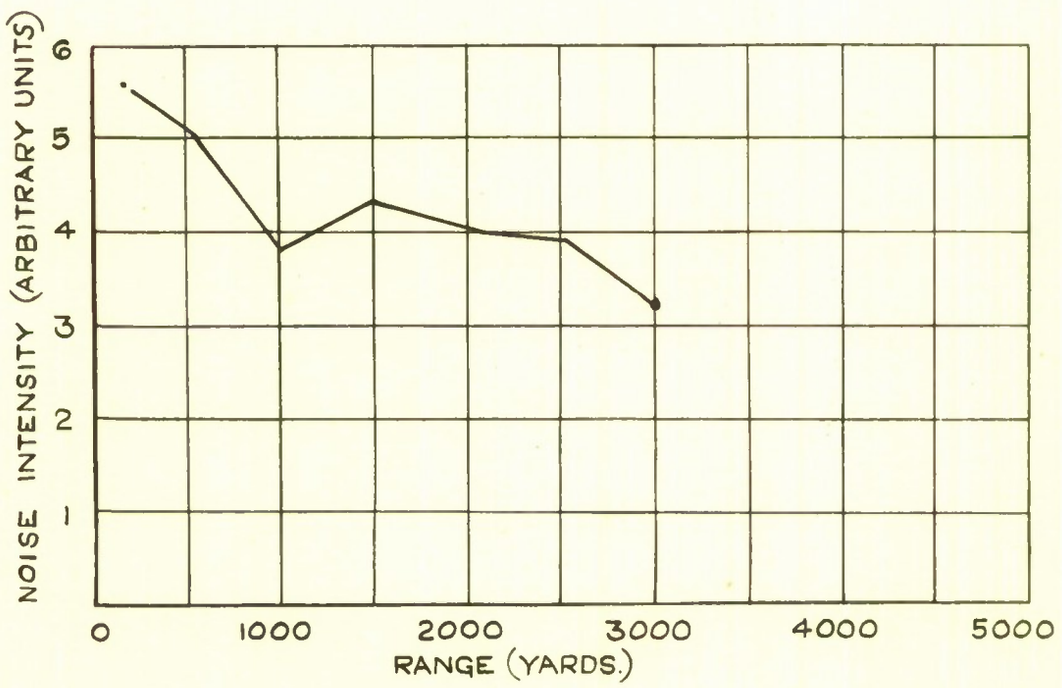
Serviceability Smoke Unit from advent of improved sealing (Trials 9, 11, 13 and 14)

Trial	Indicators	Gave Smoke	- for - under 1 min.	2-3 min.	+3-5 min.	+5 min.
* 9	6	6			3	3
11	6	6		1	1	4
13	4	4				4
14	44	42	5 or 7 ?	10	10	19
	60	58		11	14	30
		96.5%	10% approx.	18.3%	23.4%	50%

* 6 dropped into turbulent water discounted.



LENGTH OF TIME SMOKE COMPONENT FUNCTIONED.

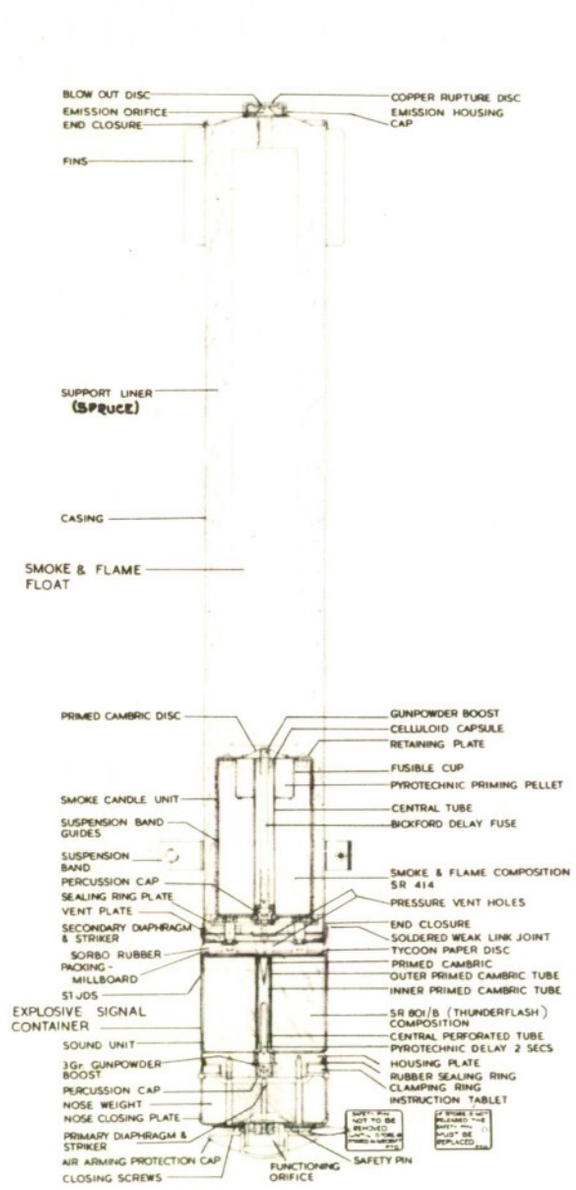


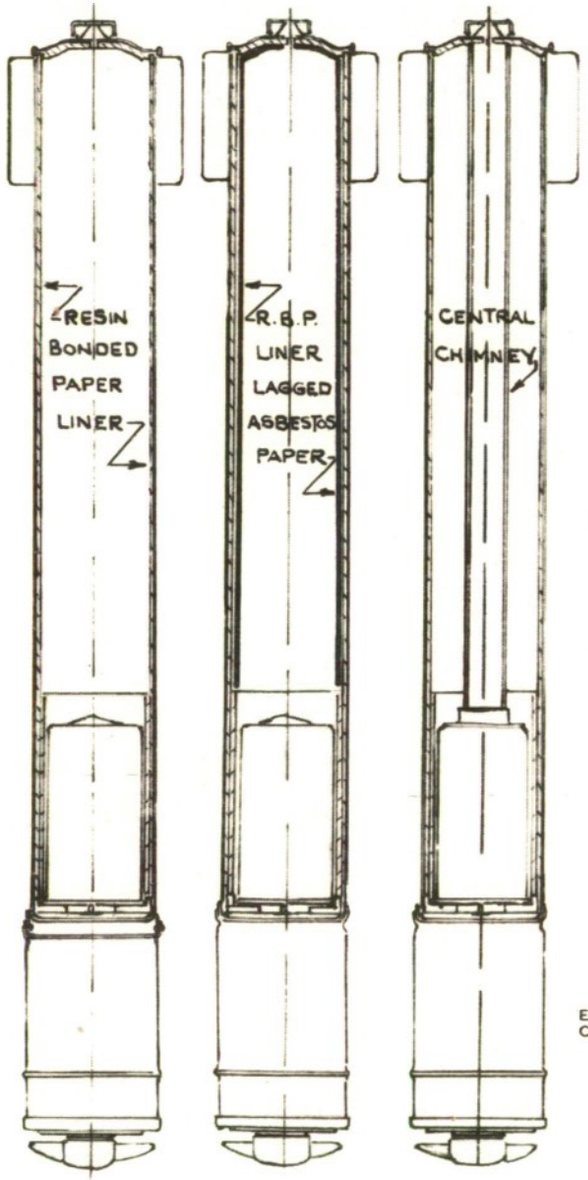
AUDIBILITY OF CHARGE.

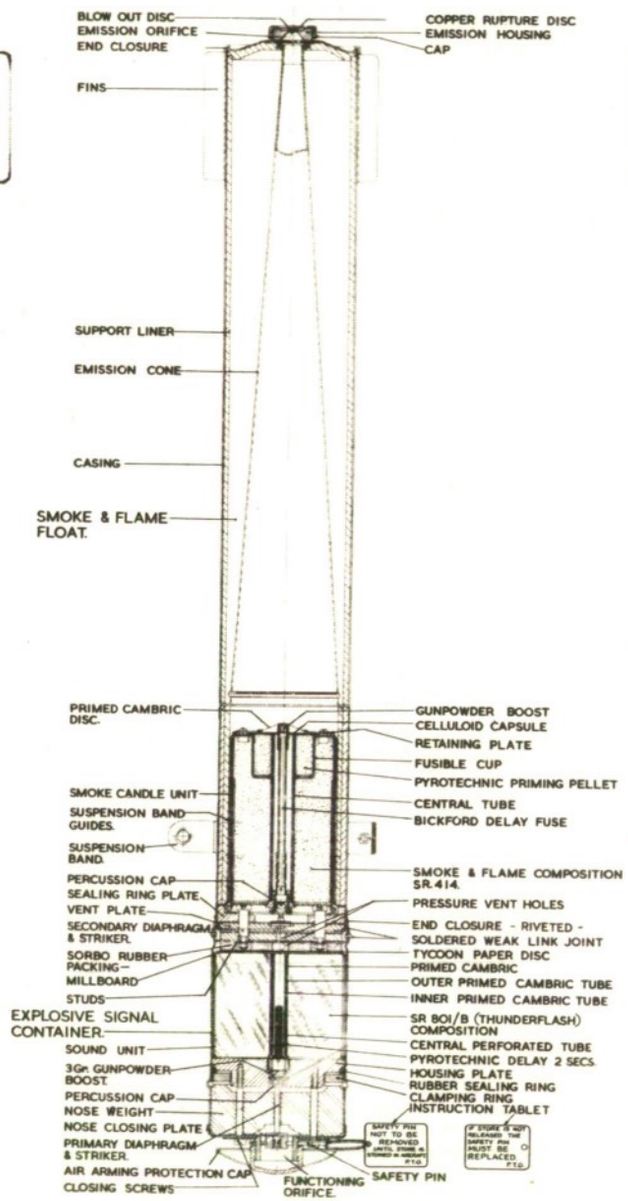
INDICATOR A/S TRAINING Nº. 1 MK 1 - A.S.W.D.U. TRIAL Nº. 337.

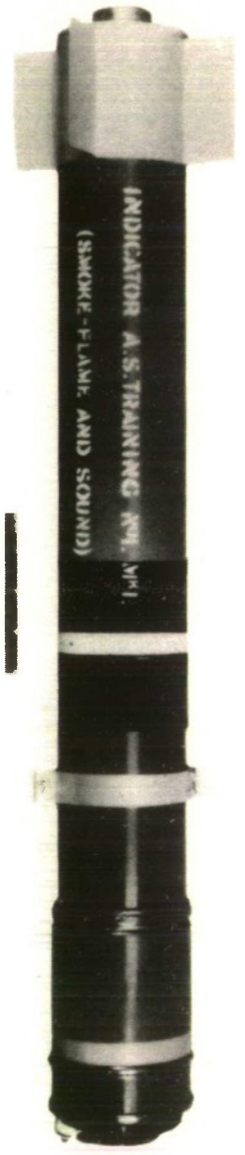
PERFORMANCE OF STORES WITH 203 SOUND CHARGE.

EX REPORT R.A.F. ST. MAWGAN - A.S.W.D.U./C20/464 TRIALS - 8/53.









1. PROTOTYPE 2 3 4 DEVELOPMENT TYPES

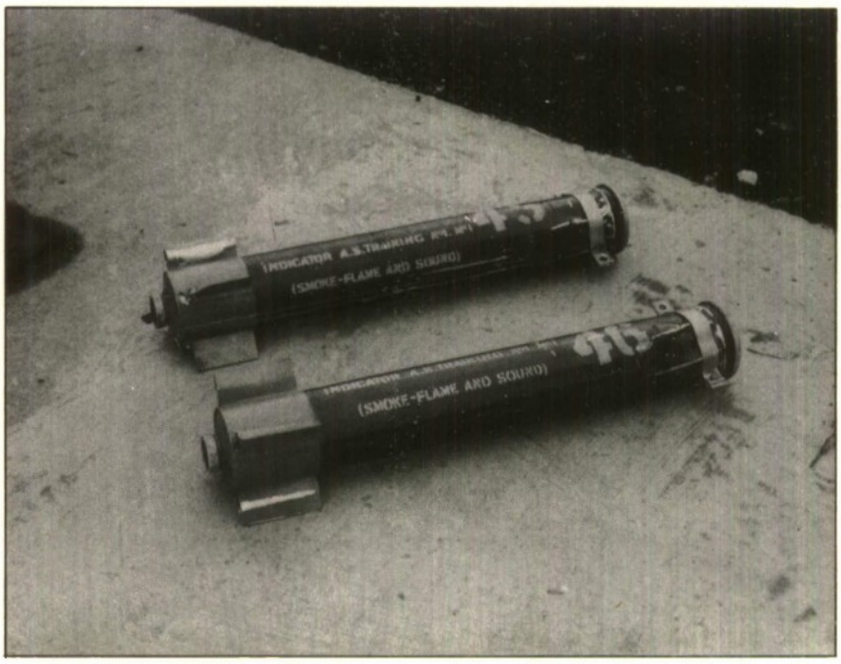
5. WITH 4 oz. EXPLOSIVE SIGNAL 6. WITH 2 oz. E.S. FINAL ARRANGEMENT

7. EXTERNAL

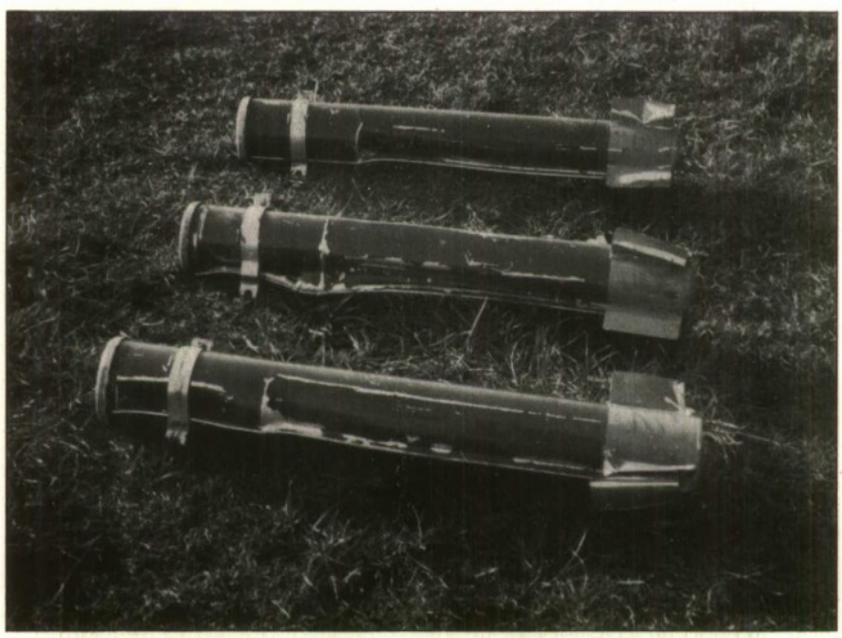
FIG.1. INDICATOR, A/S TRAINING No.1, Mk.1

TECH. NOTE: ARM. 534

FIG.1



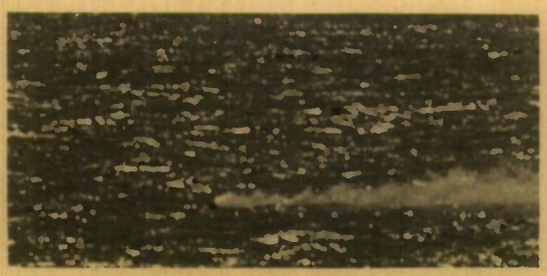
1. 24 S.W.G. (·022) M.S. OUTER CASING WITH SPRUCE SUPPORT LINER



2. 24 S.W.G. (·022) M.S. OUTER CASING LINED WITH SPRUCE AFT AND MAGNESIUM ALLOY SLEEVE CASTING FORWARD

FIG.2. INDICATOR, A/S TRAINING No.1, Mk.1

DAMAGE CAUSED TO PROTOTYPE FLOATS BY SOUND UNIT FUNCTIONING



1. No.1 - 1 min.

2. No.1 - 6 mins.

3. No.2 - 1 min.

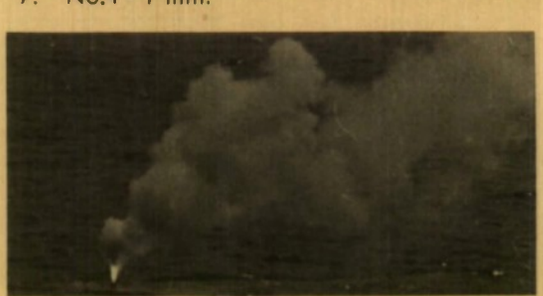
4. No.2 - 5 mins.

5. No.3 - 1 min.

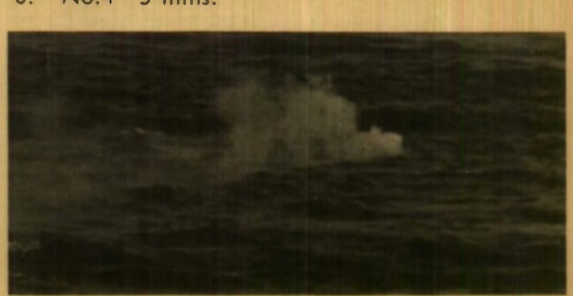
6. No.3 - 5 mins.

7. No.4 - 1 min.

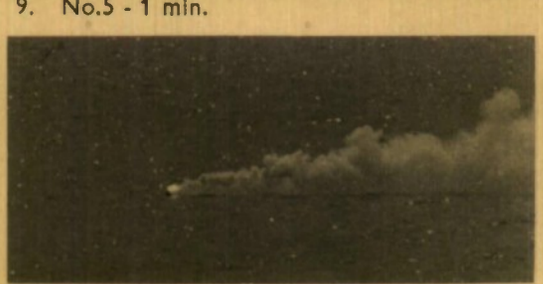
8. No.4 - 5 mins.



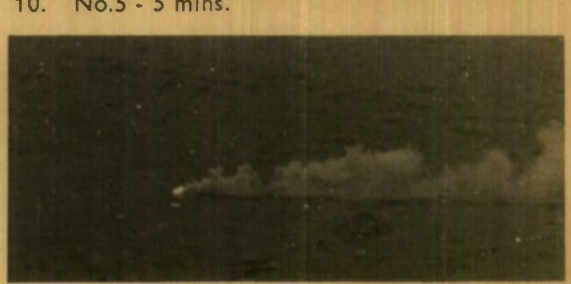
9. No.5 - 1 min.



10. No.5 - 5 mins.



11. No.6 - 1 min.



12. No.6 - 5 mins.

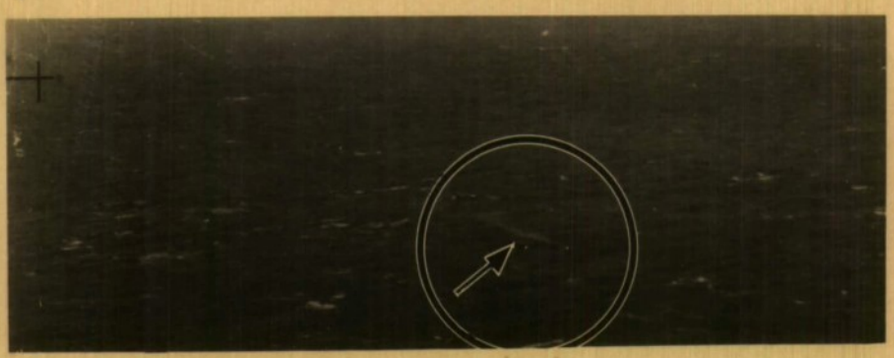
FIG.3. INDICATOR, A/S TRAINING No.1, Mk.1

DEVELOPMENT TRIAL (5) - AIR PROOF - WESTON-SUPER-MARE. 21-6-51

(PHOTOS FROM SHORE: RANGE, 250 yds. approx: WIND, LIGHT: SEA, CHOPPY)

1

EMISSIONS 2
A.S.T.I. (DROP 6)
& 1 MARKER MARINE
NO.2 SOMEWHERE.
HEIGHT
1000 FT — ESTD.
RANGE
1500 YDS



2

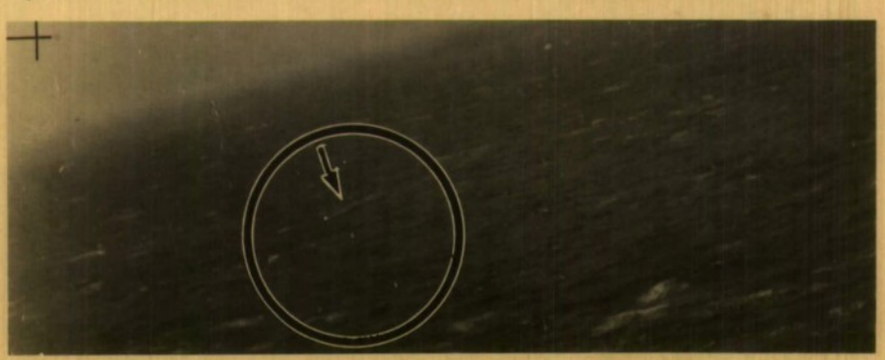
A.S.T.I. EMISSION
(DROP 8) FROM
HEIGHT
5000 FT — ESTD.
RANGE
1000 YDS

3

A.S.T.I. EMISSION
(DROP 9) FROM
HEIGHT
250 FT — ESTD.
RANGE
600 YDS

4

A.S.T.I. EMISSION
(DROP 11) FROM
HEIGHT
250 FT — ESTD.
RANGE
800 YDS
NOTE. NO REPRO-
DUCTION OF MARKER
MARINE SEEN BURNING
ALONGSIDE.



5

A.S.T.I. EMISSION
(DROP 14) FROM
HEIGHT
250 FT — ESTD.
RANGE
1000 YDS
NOTE. 2 A.S.T.I.
DROPPED - EMISSION
FROM BOTH SEEN
VISUALLY.

FIG.4. INDICATOR, A/S TRAINING No.1, Mk.1

DEVELOPMENT TRIAL (8) - AIR PROOF - ENGLISH CHANNEL, 7-1-53

(PHOTOS FROM AIR: VISIBILITY, 1-3 miles: WIND, 30 knots: SEA STATE, 3-4)

1. No.1 - RECOVERY, BURNING COMPLETED NOTE ABSENCE OF DAMAGE TO FLOAT

2. No.2 - 5½ mins.

3. No.3 - 2 mins. FROM 300 yds. approx.

4. No.3 - 4½-5 mins.

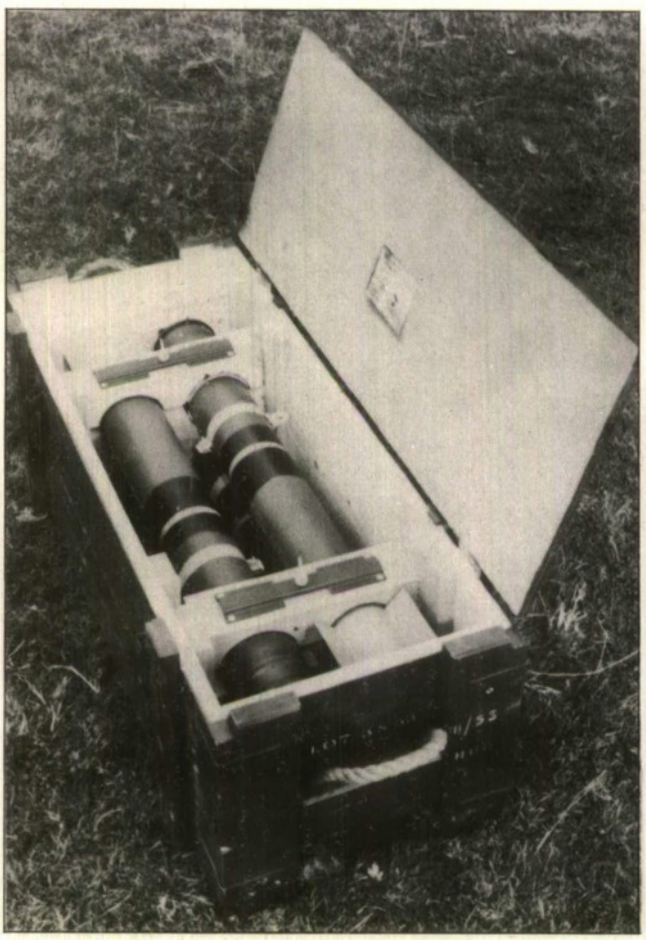
5. No.4 - 4½-5 mins.

6. No.5 - 3 mins.

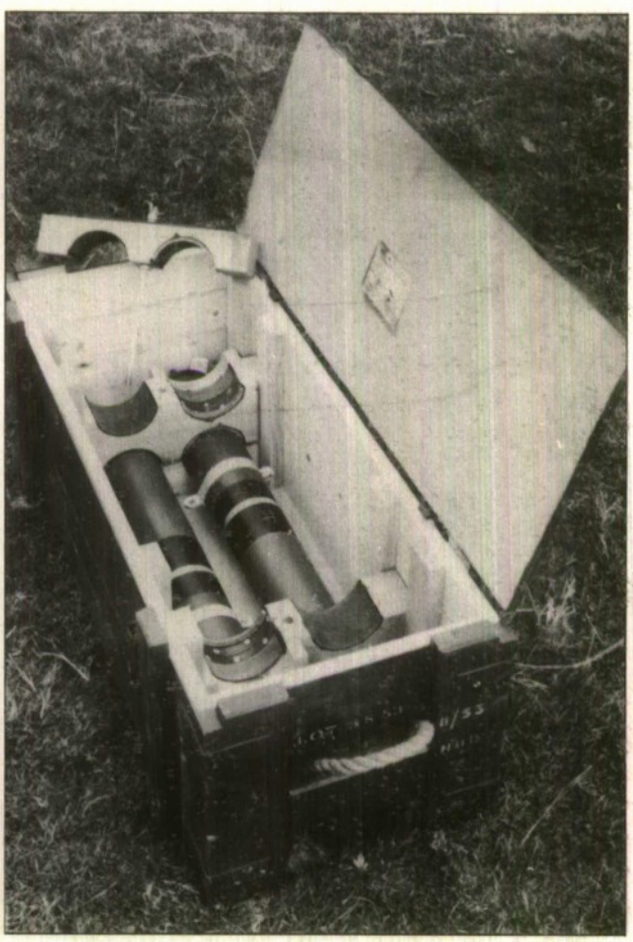
7. No.6 - 5 mins. FROM 100 yds. approx.

FIG.5. INDICATOR, A/S TRAINING No.1, Mk.1
DEVELOPMENT TRIAL (9) - AIR PROOF - WESTON-SUPER-MARE, 17-1-53
PHOTOS FROM MARINE CRAFT
(VISIBILITY, 3-4 miles: WIND, 10 knots: SEA, CALM: RANGE FROM AIR, 3-3½ miles)

1. BOX (B.628 Mk.1) EXTERNAL - SHOWING FILLED MARKING



2. METHOD OF PACKING (4) INDICATORS



3. TOP PAIR OF INDICATORS REMOVED

BOX EMPTY, 35 lbs: INDICATORS, (4) 40 lbs: GROSS, 75 lbs

FIG.6. INDICATOR, A/S TRAINING No.1, Mk.1
ARRANGEMENT FOR TRANSPORTATION AND STORAGE

Information Centre
Knowledge Services
[dstl] Porton Down,
Salisbury
Wilts
SP4 0JQ
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
U.S.A.

AD#:
Date of Search: 13 February 2007

Record Summary:

Title: Development of the indicator anti-submarine training No 1 Mk 1
Covering dates 1954
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) TECH NOTE ARM 534
Held by The National Archives, Kew

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